

CLAIMS

1. An apparatus for calculating an amount of a recirculated exhaust gas for an internal combustion engine, the engine having an intake pipe and an exhaust pipe, the intake pipe downstream of an throttle valve and the exhaust pipe being connected with each other via an exhaust gas recirculation passage, and an exhaust gas recirculation control valve for controlling an amount of recirculated exhaust gas flowing through the exhaust gas recirculation passage being disposed in the exhaust gas recirculation passage, the apparatus comprising:

means for expressing a difference between a *cylinder-charged air amount* in an engine steady operation with the recirculated exhaust gas being not supplied, and the *cylinder-charged air amount* in the engine steady operation with the recirculated exhaust gas being supplied, with a function expression of an *intake pipe pressure*, and for obtaining and storing the function expression in advance, the *cylinder-charged air amount* being an amount of fresh air charged in a cylinder, and the *intake pipe pressure* being a pressure in the intake pipe downstream of the throttle valve;

means for obtaining the *intake pipe pressure*; and

means for calculating the difference from the obtained *intake pipe pressure* using the function expression, and for calculating an *exhaust gas recirculation control valve passing-through gas amount*, which is an amount of the recirculated exhaust gas passing through the exhaust gas recirculation control valve when the exhaust gas recirculation control valve is opened, based on the difference.

2. An apparatus according to claim 1, wherein the *intake pipe pressure* in the engine steady operation is obtained, wherein the difference is calculated from the obtained *intake pipe pressure* using the function expression, and wherein an amount of the recirculated

exhaust gas charged in the cylinder in the engine steady operation is calculated based on the difference.

3. An apparatus according to claim 1, wherein the cylinder-charged air amount in the engine steady operation with the recirculated exhaust gas being not supplied is expressed with a first function expression of the intake pipe pressure, and the first function expression is obtained and stored in advance, and the cylinder-charged air amount in the engine steady operation with the recirculated exhaust gas being supplied is expressed with a second function expression of the intake pipe pressure, and the second function expression is obtained and stored in advance, wherein the cylinder-charged air amounts are respectively calculated from the obtained intake pipe pressure using the first and second function expressions, wherein a difference between these calculated cylinder-charged air amounts is calculated, and wherein the exhaust gas recirculation control valve passing-through gas amount is calculated based on the difference.

4. An apparatus according to claim 1, wherein the respective function expressions are obtained and stored in advance for different opening degrees of the exhaust gas recirculation control valve, wherein the opening degree of the exhaust gas recirculation control valve is obtained, and wherein the difference is calculated using the function expression determined in accordance with the obtained opening degree of the exhaust gas recirculation control valve.

5. An apparatus according to claim 1, wherein the respective function expressions are obtained and stored in advance for different engine speeds, wherein the engine speed is obtained, and wherein the difference is calculated using the function expression determined in accordance with the obtained engine speed.

6. An apparatus according to claim 1, wherein the function expression comprises two linear function

expressions having different gradients from each other and are continuous with each other at a connecting point.

7. An apparatus according to claim 3, wherein each of the first and second function expressions comprises
5 two linear function expressions having different gradients from each other and being continuous with each other at a respective connecting point.

8. An apparatus according to claim 1, the engine having a plurality of cylinders connected to respective
10 intake branches, wherein the exhaust gas recirculation passage downstream of the exhaust gas recirculation control valve is forked into branches connected to the respective intake branches, wherein chokes are provided in the branches of the exhaust gas recirculation passage,
15 wherein an amount of the recirculated exhaust gas passing through the respective chokes and flowing into the respective intake branches is calculated based on the difference.

9. An apparatus according to claim 1, wherein an
20 intake control valve is provided for controlling an air flow in the intake pipe downstream of the throttle valve, wherein the respective function expressions are obtained and stored in advance for different opening degrees of the intake control valve, wherein the opening degree of
25 the intake control valve is obtained, and wherein the difference is calculated using the function expression determined in accordance with the obtained opening degree of the intake control valve.

10. An apparatus according to claim 9, wherein the
30 intake control valve comprises an intake pipe length control valve for controlling the effective length of the intake pipe.

11. An apparatus according to claim 9, wherein the
intake control valve comprises a swirl or tumble control
35 valve for controlling formation of a swirl or tumble flow in the cylinder.

12. An apparatus according to claim 9, wherein at

least one parameter defining the function expression is changed gradually when the opening degree of the intake control valve is changed.

5 13. An apparatus according to claim 1, wherein the function expression expresses the difference when an engine environmental condition is a predetermined reference environmental condition, wherein a representative value representing the engine
10 environmental condition is obtained, and wherein the difference calculated using the function expression, or the *exhaust gas recirculation control valve passing-through gas amount*, is corrected based on the representative value.

15 14. An apparatus according to claim 1, wherein an engine coolant temperature is obtained, and wherein the difference or the *exhaust gas recirculation control valve passing-through gas amount* is corrected based on the engine coolant temperature.

20 15. An apparatus according to claim 1, the internal combustion engine having an ignition plug, wherein when a retardation correction of ignition timing is performed, the difference or the *exhaust gas recirculation control valve passing-through gas amount* is corrected based on an amount of the retardation correction of the ignition
25 timing.

 16. An apparatus according to claim 1, wherein when increasing correction of the fuel supply amount is performed, the difference or the *exhaust gas recirculation control valve passing-through gas amount* is
30 corrected based on an amount of the increasing correction of the fuel supply amount.

 17. An apparatus according to claim 1, wherein the *intake pipe pressure* is detected by a pressure sensor disposed in the intake pipe downstream of the throttle
35 valve, and wherein the difference is calculated from the detected *intake pipe pressure* using the function expression.

18. An apparatus according to claim 1, wherein an opening degree of the throttle valve is obtained, wherein the *intake pipe pressure* is estimated based on the obtained opening degree of the throttle valve, and
5 wherein the difference is calculated from the estimated *intake pipe pressure* using the function expression.

19. An apparatus according to claim 1, wherein an amount of fresh air flowing through the intake pipe is detected by an air flow meter, wherein the *intake pipe*
10 *pressure* is estimated based on the detected amount of the fresh air, and wherein the difference is calculated from the estimated *intake pipe pressure* using the function expression.

20. An apparatus according to claim 19, wherein the
15 difference is maintained at a predetermined constant value when the estimated *intake pipe pressure* exceeds the maximum pressure.